

EFFECTS OF LONG DURATION SPACEFLIGHT ON VENOUS AND ARTERIAL COMPLIANCE

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BACKGROUND

The visual impairment and intracranial pressure syndrome (VIIP) is a newly described space flight-associated medical condition made up of a constellation of symptoms affecting at least 34% of American astronauts who have flown International Space Station (ISS) missions. VIIP is defined primarily by visual acuity deficits and anatomical changes to eye structures, and is thought to be related to elevated intracranial pressure secondary to space flight-induced cephalad fluid shifts. Loss of visual acuity could be a significant threat to crew health and performance and may be suggestive of other adaptations with implications for years post-flight.

PURPOSE

Our primary objective is to determine whether vascular compliance is altered by space flight and whether such adaptations are related to the incidence of VIIP. In particular, we will measure ocular parameters and vascular compliance in vessels of the head and neck in astronauts who have no space flight experience, in astronauts before, during, and after space flight, and in bed rest subjects with conditions similar to space flight. Additionally, we will analyze astronaut data from the Lifetime Surveillance of Astronaut Health (LSAH) archive to determine which factors might be predictive of the development of VIIP. The project will be conducted in four separate but related parts.

METHODS

To understand the baseline condition of astronauts without any prior space flight experience, we will study 10 astronauts who have never flown in space by performing a comprehensive evaluation of the vasculature of the head, neck and eyes. Hemodynamic data (stroke volume and blood pressure), ocular (tonometry and ocular ultrasound), venous and arterial parameters will be acquired across a range of tilt angles (20, 10, 0, -10, -20 degrees). Vessels to be studied include the temporal, jugular, and vertebral veins and the cerebral, carotid and vertebral arteries. Ophthalmic data from the annual physical will be obtained through data sharing.

To examine the relation between vascular compliance in the head and neck and the development of VIIP after a long duration space flight, we will study 10 astronauts before, during, and after long-duration ISS missions. Pre- and post-flight testing will be identical to that described above. During flight, images of the same vessels of interest will be obtained for later analysis. Ophthalmic data including VIIP scores will be obtained through data sharing from medically-required tests.

To investigate the effects of age and elevated sodium intake, two potential contributors to VIIP, we will study 24 men (in two age groups: 25-35 and 45-55) during a 14 day 6° head-down bed rest, a well-accepted analog of space flight. Standard NASA bed rest conditions will be maintained except for dietary sodium. Sodium intake will be similar to that of ISS astronauts, which is higher than consumed in previous bed rest studies. Pre- and post-bed rest testing procedures will be identical to the testing protocol described above for astronauts. Ophthalmic testing (optical coherence tomography, fundoscopy, and tonometry) will be conducted on the same day that vascular compliance measures are obtained.

To identify parameters that may relate to an increase in an astronaut's susceptibility to developing VIIP, we will use data mining techniques to evaluate astronaut data obtained from the LSAH. Medical history, family history, space flight history and its related exposures, and history of high performance jet aircraft exposure will be examined for their potential relationship to ocular data.

EXPECTED RESULTS

We hypothesize that the cephalad fluid shift induced by space flight will result in structural and functional adaptations in head and neck vessels leading to decreased vascular compliance and related to the development of VIIP symptoms. Further, although VIIP has not been observed in previous bed rest studies, we hypothesize that an elevated sodium intake will increase the incidence of VIIP symptoms in this space flight analog. Finally, we hypothesize that data mining analyses will reveal relationships between health history, previous exposures (including space flight and high performance aircraft), and the development of VIIP in the astronaut population.